*Short Research Article*

Assessing Environmental Health Through Physicochemical Analysis of the Sabangan River, Barangay Can-ayan, Malaybalay City, Bukidnon

.

ABSTRACT

|  |
| --- |
| **Aims:** This study aimed to assess the physicochemical water quality of the Sabangan River in Barangay Can-ayan, Malaybalay City, Bukidnon. Specifically, it evaluated total dissolved solids (TDS), turbidity, dissolved oxygen (DO), pH, and total alkalinity in upstream, midstream, and downstream sections of the river to determine compliance with the Department of Environment and Natural Resources (DENR) Class C standards for recreational waters.**Study design:** This study employed a qualitative descriptive research design to characterize the physicochemical properties of the river water based on observed and measured parameters.**Place and Duration of Study:** The study was conducted at the Sabangan River, Barangay Can-ayan, Malaybalay City, Bukidnon, Philippines. Sampling was conducted early in the morning on April 8, 2024.**Methodology:** Water samples were collected and analyzed ex-situ at F.A.S.T. Laboratories to determine key physicochemical parameters using standard laboratory methods. pH was assessed using the 4500 H+B electrometric method, turbidity was measured through 2130 B Nephelometry, TDS was determined via 2540 C Gravimetry, DO was analyzed using the 4500 oC Azide modification method, and total alkalinity was tested through 2320 B Titrimetry.**Results:** The analysis revealed that TDS was 146.67 mg/L, turbidity was 0.413 NTU, DO was 8.47 mg/L, pH was 8.26, and total alkalinity was 112 mg/L. All measured parameters were within the DENR Class C standards for recreational waters, indicating low levels of dissolved impurities, high water clarity, and a well-buffered aquatic system. **Conclusion:** The findings suggest that the Sabangan River maintains good water quality for recreational use. However, continuous monitoring is recommended to prevent potential contamination from tourism and local activities. Future research should examine additional water quality indicators such as biochemical oxygen demand (BOD), fecal coliform levels, nutrient concentrations, and heavy metal contamination to provide a more comprehensive assessment of the river's ecological health. |

*Keywords:dissolved oxygen, pH, total alkalinity, total dissolved solids, total alkalinity, turbidity, physicochemcial analysis, Sabangan River, water quality*

1. INTRODUCTION

Water quality in river ecosystems is crucial for ecological stability, biodiversity conservation, and human well-being, especially for recreational activities such as swimming, fishing, and boating (Doi et al., 2013). Healthy river systems support biodiversity, regulate nutrient cycles, and provide safe human and aquatic life environments. However, poor water quality threatens the environmental balance and public health, as pollution introduces harmful substances such as chemicals, heavy metals, and microorganisms into river systems (Cheng et al., 2023; Jennings et al., 2023; Ezekiel et al., 2023; Ruan et al., 2023). Assessing water quality is essential for monitoring physicochemical properties such as pH, dissolved oxygen, total dissolved solids, turbidity, and alkalinity, ensuring compliance with environmental regulations and safeguarding public health (Adelagun et al., 2021).

Several studies have assessed river water quality in Malaybalay City and surrounding areas, but key tributaries remain underexplored. Damasco et al. (2024) conducted a physicochemical assessment of Kalawaig Creek, analyzing parameters such as dissolved oxygen, pH, total dissolved solids, and alkalinity. Similarly, Bete et al. (2024) studied the Tagoloan River, evaluating temperature, conductivity, salinity, nitrates, phosphates, and fecal coliforms. Their findings indicated high salinity from wastewater and excessive fecal coliform levels, classifying the river as marginal for primary contact use. While these studies provide valuable insights, the Sabangan River, which the Kibalabag River feeds before merging with the Tagoloan River, has still not been thoroughly studied. Given its importance in recreation and ecology, assessing its physicochemical properties is essential for understanding its current state and implementing effective water management strategies.

The Sabangan River is crucial in maintaining ecological balance and supporting livelihoods, tourism, and biodiversity. It is a popular recreational site, but human activities such as tourism, land use changes, and potential agricultural runoff may introduce pollutants that could compromise water quality and long-term sustainability. Aside from its environmental importance, the river has cultural and historical significance; it has long been a meeting place for tribal leaders and is regarded as a site of ancestral heritage. Additionally, the Kibalabag River, which flows into the Sabangan River, is the primary water source for Malaybalay City, further emphasizing the need for continuous water quality monitoring. Given increasing environmental pressures, assessing the Sabangan River's physicochemical properties is necessary to safeguard local livelihoods, inform future management decisions, and support conservation efforts.

Given the fundamental role of water quality in sustaining both ecological balance and human health, numerous studies have assessed the physicochemical properties and pollution levels of rivers in the region. For instance, Lubos et al. (2020) examined the Sawaga River, a tributary of the Tagoloan River that serves as a critical water source for Malaybalay. Their findings revealed alarming pollution levels, emphasizing the need for ongoing water quality monitoring in local water sources. Their study found alarming pollution levels, such as high concentrations of ammonia, nitrite, and total coliforms, which have raised concerns about water safety for domestic use and local fisheries. Similarly, research by Opiso and Alburoa (2014) on the Sawaga River highlighted elevated nitrate levels, moderately acidic pH, and high total suspended solids, indicating the impacts of agricultural runoff and nearby settlements on water quality. In other parts of the country, studies on rivers like the Sindangan River (Laranjo et al., 2023) and the Pagbanganan River (Villarmino & Quevedo, 2021) have also identified concerning trends, including rising total suspended solids and phosphate levels, pointing to the need for ongoing monitoring and pollution control. In addition, Rahman et al. (2021) examined seasonal variations in physicochemical parameters on the Turag River, showing how changes in water quality can vary with the seasons, affecting the overall ecosystem. These studies underscore the importance of assessing and managing river systems to ensure water quality and mitigate the impact of anthropogenic activities, which is particularly relevant to our study of the Sabangan River.

This study aimed to conduct a comprehensive physicochemical assessment of the Sabangan River, specifically focusing on parameters such as total dissolved solids (TDS), dissolved oxygen (DO), turbidity, total alkalinity, and pH. This study seeks to provide valuable insights into the river's water quality and potential hazards by addressing the existing research gap. The findings will support policymakers and stakeholders in developing effective management strategies to preserve the Sabangan River's ecological and cultural value for present and future generations.

2. material and methods

**2.1 Research design**

This qualitative study used a descriptive research design to examine the physicochemical parameters of the Sabangan River in Barangay Can-Ayan, Malaybalay City, Bukidnon. The study aimed to assess key parameters such as turbidity, total dissolved solids (TDS), dissolved oxygen (DO), hydrogen ion concentration (pH), and total alkalinity, providing a detailed examination of these variables. Field research techniques were utilized to collect data directly from the river's ecosystem, ensuring accuracy and reliability. Additionally, qualitative analysis methods were applied to interpret the collected data, comprehensively describing the river's physicochemical characteristics. The study also assessed spatial variations across upstream, downstream, and midstream locations to provide insights into the Sabangan River's ecological conditions.

**2.2 Entry Protocol**

All necessary permissions were obtained from the relevant authorities to conduct research outside San Isidro College and in all designated study sites. Formal letters outlining the study’s objectives, scope, and duration were submitted to ensure compliance with institutional and regulatory requirements. Approval from the principal of the Integrated Basic Education Department (IBED) authorized off-campus research, while parental consent was secured to uphold ethical standards and ensure the safety of the student researchers. Additionally, authorization from the City Environment and Natural Resources Office (CENRO) of Malaybalay City permitted field studies and sample collection at the Sabangan River, enabling the successful execution of the study.

Figure 1. Map of Study Site Sabangan River



**2.3 Study Site**

Three sampling stations were established along the Sabangan River: the upstream location at 8°12'27.7"N and 125°09'01.4"E, the midstream location at 8°12'22.0"N and 125°08'57.6"E, which is the most popular recreational site for tourists, and the downstream location at 8°12'20.3"N and 125°08'53.8"E, where the Can-Ayan River meets the Sabangan River, forming the Tagaloan River. Sampling was conducted on April 8, 2024, with the upstream sample collected at 6:37 am, the midstream sample at 6:44 am, and the downstream sample at 6:49 am.

**2.4 Collection and Analysis of Physicochemical Parameters**

Sampling points were strategically chosen along the river to capture water quality variations across upstream, midstream, and downstream locations, adapting the protocols from Igloria et al. (2024) but modified to match the needs of the study. Transect walks were conducted to collect water samples systematically, with grab samples taken from the mid-depth of each stream. The sampling distances were approximately 170.28 meters between the upstream and midstream stations and 165.69 meters between the midstream and downstream stations. Water samples were collected using sterile polyethylene bottles, following strict sterilization protocols to prevent contamination. Each sample was carefully labeled with relevant information, including the sampling location, date, and time, and was placed in a cooler chilled to 4°C for transportation to F.A.S.T. Laboratories. Documentation was maintained to track sample handling and processing. The water samples were analyzed at the laboratory for key physicochemical parameters, including pH, turbidity, DO, TDS, and total alkalinity. The methods employed were pH testing using the 4500 H+B electrometric method, turbidity testing utilizing 2130 B Nephelometry, TDS analysis through 2540 C Gravimetry, DO using the 4500 oC Azide modification method, and total alkalinity tested via 2320 B Titrimetry. These methods were specifically conducted by F.A.S.T. Laboratories, ensuring consistency and accuracy. Stringent quality control measures were applied throughout the analysis to ensure the reliability and accuracy of the data. The results from the physicochemical analysis were then compared to the Department of Environment and Natural Resources (DENR) standards for C water resources to assess compliance with the required water quality guidelines.

3. results and discussion

**3.1 Physical Properties**

**3.1.1 Total Dissolved Solids**

**Table 1. Total Dissolved Solids Results**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Parameter** | **Up****stream** | **Mid****stream** | **Down****stream** | **Average** | **Standard** |
| Total Dissolved Solids (mg/L) | 178 | 168 | 94 | 146.67 | >1,000 mg/L |

Table 1 presents the Total Dissolved Solids (TDS) concentrations across the Sabangan River. The upstream site recorded 178 milligrams per liter, midstream 168 milligrams per liter, and downstream 94 milligrams per liter, with an overall average of 146.67 milligrams per liter. These values are well below the DENR Class C standard of 1,000 milligrams per liter, indicating minimal dissolved salts, minerals, and organic matter (Muchanga & Sichingabula, 2021; Mathur et al., 2024; Paudel et al., 2024).

These low TDS levels suggest that the Sabangan River is suitable for drinking, irrigation, and aquatic life. High TDS concentrations can affect water taste, hardness, and palatability, potentially causing gastrointestinal discomfort if consumed at excessive levels (Lemessa et al., 2023). Elevated TDS, particularly when composed of sodium, sulfate, or chloride ions, has been associated with hypertension and kidney-related issues in sensitive individuals (Pushpalatha et al., 2022). Since the Sabangan River’s TDS values remain well within safe limits, it presents no immediate health risks, but continuous monitoring is necessary to prevent contamination from anthropogenic sources.

Comparative studies highlight variations in TDS levels across different Philippine rivers. Labajo-Villantes and Nuñeza (2014) found TDS levels in the Labo and Clarin Rivers ranging from 27.0 to 71.0 milligrams per liter, averaging 59 milligrams per liter, aligning with the DENR’s water quality guidelines. Meanwhile, the Meycauayan River recorded TDS levels of 249.55 milligrams per liter upstream, 325 milligrams per liter midstream, and 481.40 milligrams per liter downstream, averaging 351.98 milligrams per liter (Pleto et al., 2020). These comparisons confirm that the Sabangan River remains within safe limits for environmental and human health.

**3.1.2 Turbidity**

**Table 2. Turbidity Results**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Parameter** | **Up****stream** | **Mid****stream** | **Down****stream** | **Average** | **Standard** |
| Turbidity (NTU) | 0.42 | 0.41 | 0.41 | 0.413 | >5 NTU |

Table 2 presents turbidity levels, with values of 0.42 nephelometric turbidity units upstream, 0.41 nephelometric turbidity units midstream, and 0.41 nephelometric turbidity units downstream, averaging 0.413 nephelometric turbidity units. These values are exceptionally low and fall well below the DENR Class C standard of 5 nephelometric turbidity units, indicating clear water conditions with minimal suspended solids or microbial contamination (Muchanga & Sichingabula, 2021; Malaki et al., 2024).

Turbidity is an important indicator of water safety since high turbidity levels can shield pathogens from disinfection processes, increasing the risk of waterborne diseases such as diarrhea, cholera, and giardiasis (Jayasekara et al., 2024). High turbidity has also been linked to skin and eye irritation, particularly in recreational waters (Awogbami et al., 2023). The Sabangan River’s low turbidity suggests a low risk of microbial contamination, reinforcing its suitability for recreational use. However, regular assessments of microbial content remain essential to ensure long-term safety.

Comparative studies show that rivers exposed to urban runoff and mining activities often exhibit significantly higher turbidity levels. The Sapangdaku River in Toledo City, Cebu, recorded turbidity values ranging from 22 nephelometric turbidity units upstream to 35 nephelometric turbidity units midstream, surpassing DENR standards and indicating poor water quality (Sanchez et al., 2020). Conversely, the Egaña River in Sibalom, Antique, had a turbidity level of 1.27 nephelometric turbidity units, reflecting good water quality (Alimen et al., 2019). Similarly, the Ciambulawung River in Banten Province reported turbidity levels between 1.50 and 3.70 nephelometric turbidity units, averaging 2.30 nephelometric turbidity units, all within safe limits (Effendi et al., 2015). These comparisons highlight that the Sabangan River remains in an optimal state, free from significant suspended sediments or pollutants.

**3.2 Chemical Properties**

**3.2.1 Dissolved Oxygen**

**Table 3. Dissolved Oxygen Results**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Parameter** | **Up****stream** | **Mid****stream** | **Down****stream** | **Average** | **Standard** |
| Dissolved Oxygen (mg/L) | 8.5 | 8.4 | 8.5 | 8.47 | <5 mg/L |

Table 3 presents the Dissolved Oxygen (DO) concentrations, which averaged 8.47 milligrams per liter, exceeding the DENR minimum standard of 5 milligrams per liter for Class C waters. This high DO level indicates a well-oxygenated river system, crucial for supporting fish and other aquatic life (Auta et al., 2023; Mathur et al., 2024).

Dissolved oxygen is a key indicator of water quality, as it measures the availability of oxygen for aquatic organisms. The Sabangan River’s swift-moving waters likely facilitate oxygen dissolution, supporting a stable and biologically active ecosystem (USGS, 2019). High DO levels generally suggest low organic pollution and healthy biochemical processes, reinforcing the pristine condition of the river (Auta et al., 2023).

Studies on other rivers have revealed lower DO concentrations. The Labo and Clarin Rivers recorded DO levels between 1.52 and 4.57 milligrams per liter, averaging 2.76 milligrams per liter, which, although within acceptable limits, remain below the DENR’s 5-milligram-per-liter threshold (Labajo-Villantes & Nuñeza, 2014). Similarly, the Meycauayan River exhibited DO levels ranging from 0.49 to 0.98 milligrams per liter, averaging 3.34 milligrams per liter, indicating poorer water quality (Pleto et al., 2020). These comparisons emphasize that the Sabangan River supports a healthier aquatic system than many urban and industrial-impacted rivers.

Low DO levels in water bodies can lead to the proliferation of anaerobic bacteria, including those that produce toxic compounds such as hydrogen sulfide and methane, which are harmful when inhaled or ingested (Guo et al., 2022). Reduced oxygen availability can also promote the growth of harmful algal blooms, producing toxins that cause respiratory and gastrointestinal illnesses in humans (Rocha et al., 2023). Since the Sabangan River maintains high DO levels, it supports a healthy aquatic ecosystem with minimal risks of hypoxia-related hazards.

**3.2.2 pH**

**Table 4. pH Results**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Parameter** | **Up****stream** | **Mid****stream** | **Down****stream** | **Average** | **Standard** |
| pH | 8.30 | 8.26 | 8.22 | 8.26 | 6.5-8.5 |

Table 4 presents the pH values across the Sabangan River, with an average of 8.26, ranging from 8.30 upstream to 8.22 downstream. These values fall within the DENR Class C standard of 6.5 to 8.5, indicating a stable and well-buffered aquatic environment (Mathur et al., 2024; Paudel et al., 2024).

A pH of 8.26 suggests a slightly alkaline environment, typical of river systems influenced by carbonate weathering, especially in areas with limestone or dolomite bedrock. The presence of bicarbonate ions (HCO₃⁻) contributes to this alkalinity, helping to neutralize acidic inputs and ensuring a balanced ecosystem (Mathur et al., 2024; Paudel et al., 2024).

Comparative studies in other Philippine rivers report similar pH conditions. Alimen et al. (2019) recorded a pH of 8.15 in the Egaña River, indicating good water quality. In contrast, the Sawaga River exhibited more variable pH levels of 7.73 upstream, 6.63 midstream, and 7.80 downstream, demonstrating greater fluctuations in acidity and buffering capacity (Bertomen et al., 2017). The Sabangan River’s consistent pH values reinforce its stability and ecological health.

pH plays a crucial role in water safety, as extremely low or high pH values can cause skin irritation, eye discomfort, and gastrointestinal distress (pH of Water: Environmental Measurement Systems, 2019). Water with a pH above 8.0 can reduce the effectiveness of chlorine disinfection, increasing the risk of microbial contamination (Obasi & Akudinobi, 2020). While the Sabangan River’s pH remains within a safe range, continued monitoring is recommended to detect any potential shifts due to pollutant inputs or climate variability.

**3.2.3 Total Alkalinity**

**Table 5. Total Alkaliity Results**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Parameter** | **Up****stream** | **Mid****stream** | **Down****stream** | **Average** | **Standard** |
| Total Alkalinity (mg/L) | 112 | 112 | 112 | 112 | 5-500 mg/L |

Table 5 presents the total alkalinity of the Sabangan River, with an average concentration of 112 milligrams per liter, consistent across all sampling sites. This level falls within the recommended range of 5 to 500 milligrams per liter, indicating a strong buffering capacity that prevents pH fluctuations (Lawson, 1995).

Total alkalinity refers to the water’s ability to neutralize acids, primarily controlled by hydroxide (OH⁻), bicarbonate (HCO₃⁻), and carbonate (CO₃²⁻) ions. The observed alkalinity in the Sabangan River suggests a well-buffered system, reducing the likelihood of acidification from pollutants or acidic rainfall (Mathur et al., 2024; Paudel et al., 2024).

Comparisons with other Philippine rivers highlight the importance of alkalinity in maintaining water stability. The Carangan Estero in Ozamiz City recorded alkalinity values between 8.6 and 16.7 milligrams per liter, significantly lower than those in the Sabangan River, making it more susceptible to acidification (Enguito et al., 2013). Conversely, the Jalaur River in Iloilo exhibited alkalinity levels above 100 milligrams per liter, similar to those found in the Sabangan River, reinforcing its stable water chemistry (Borlongan et al., 2013).

Low alkalinity can result in unstable pH conditions, making water more susceptible to acidification, which can lead to the release of toxic metals such as lead and copper (Boyd, 2015). Chronic exposure to low-alkalinity water has been linked to respiratory issues and increased risks of heavy metal poisoning (Ezenwa et al., 2023). In contrast, excessively high alkalinity can give water an unpleasant taste and lead to calcium carbonate buildup, affecting water pipes and infrastructure (Amadi et al., 2023). Since the Sabangan River maintains moderate alkalinity levels, it provides a stable chemical environment that minimizes health risks.

4. Conclusion

The physical parameter results revealed consistently low levels of Total Dissolved Solids (TDS) and turbidity throughout the Sabangan River. Regular monitoring is recommended to maintain these favorable conditions and address any potential sources of contamination promptly. The chemical parameter analysis indicates healthy levels of dissolved oxygen, pH, and total alkalinity, suggesting the need for continued monitoring to detect fluctuations due to seasonal variations or anthropogenic activities, ensuring the river's long-term sustainability. Further investigation into parameters such as nutrient levels, heavy metal concentrations, and microbial contamination could inform ongoing monitoring efforts to safeguard water quality and ecosystem integrity. Additionally, conducting the study during the wet season is recommended, as this study was done during the dry season.

References

Doi, H., Katano, I., Negishi, J. N., Sanada, S., & Kayaba, Y. (2013). Effects of biodiversity, habitat structure, and water quality on recreational use of rivers. *Ecosphere*, *4*(8), 1–11. https://doi.org/10.1890/es12-00305.1

Cheng, Y., Kang, Q., Liu, K., Cui, P., Zhao, K., Li, J., Ma, X., & Ni, Q. (2023). Impact of Urbanization on Ecosystem Service Value from the Perspective of Spatio-Temporal Heterogeneity: A Case Study from the Yellow River Basin. *Land*, *12*(7), 1301. <https://doi.org/10.3390/land12071301>

Jennings, J. C., Bellmore, J. R., Armstrong, J. B., & Wisseman, R. W. (2023). Effects of process‐based floodplain restoration on aquatic macroinvertebrate production and community structure. *River Research and Applications*, *39*(9), 1709–1723. https://doi.org/10.1002/rra.4174

Ezekiel, B. B., Adelalu, T. G., Christopher, J. N., & Alhassan, T. (2023). Assessment of agro allied chemical pollution on surface water quality of River Lamurde and Mayo-Gwoi, Jalingo, Taraba State, Nigeria. *Advances in Environmental and Engineering Research*, *04*(01), 1–21. https://doi.org/10.21926/aeer.2301008

Ruan, J., Cui, Y., Meng, D., Wang, J., Song, Y., & Mao, Y. (2023). Integrated prediction of water pollution and risk assessment of water system connectivity based on dynamic model average and model selection criteria. *PLoS ONE*, *18*(10), e0287209. https://doi.org/10.1371/journal.pone.0287209

Adelagun, R. O. A., Etim, E. E., & Godwin, O. E. (2021). Application of Water Quality Index for the Assessment of Water from Different Sources in Nigeria. In *IntechOpen eBooks*. https://doi.org/10.5772/intechopen.98696

Damasco, L. A., Arocha, V. J. D., Quilang, E. B., Damole, D. M. C., Miones, L. B. E., & Saldo, I. J. P. (2024). Rapid physicochemical assessment of Kalawaig Creek in Bukidnon, Philippines. *Asian Journal of Biological and Life Sciences*, *13*(1), 176–186. https://doi.org/10.5530/ajbls.2024.13.23

Bete, M. A., O, M. C. J., & Salesa, V. D. (2024). Water quality assessment in Tagoloan River, Sabangan, Can-ayan, Malaybalay City, Bukidnon. *International Journal of Science and Research (IJSR)*, *13*(7), 1085–1090. https://doi.org/10.21275/sr24718113931

Lubos, L. C., Barroso, C. J. V., Tantoy, O. A., Cuenco, M. a. T., & Lubos, L. C. (2020). Water Quality of Sawaga River and the Relationship of Socio-Economic and Health Status of its Surrounding Communities. *Liceo Journal of Higher Education Research*, *16*(2). https://doi.org/10.7828/ljher.v16i2.1374

Opiso, E. M., & Alburoa, J. L. R. (2014). Hydro-Geochemical characteristics of Sawaga River, Malaybalay City, Bukidnon. *Liceo Journal of Higher Education Research*, *10*(1). https://doi.org/10.7828/ljher.v10i1.669

Laranjo, R. D., Naguit, M. R. A., Jamolod, F. C., Jambre, K. G. E., Cabornay, N. I., Bernido, V. B., & Gahisan, M. D. S. (2023). Evaluation of the physicochemical parameters on the water quality of the major rivers of Zamboanga del Norte, Philippines. *AIMS Environmental Science*, *10*(3), 382–397. https://doi.org/10.3934/environsci.2023022

Villarmino, J., & Quevedo, E. S. (2021). Physicochemical Characterization of the Water in Pagbanganan River, Baybay City, Leyte, Philippines. *ResearchGate*. https://www.researchgate.net/publication/353314435\_Physicochemical\_Characterization\_of\_the\_Water\_in\_Pagbanganan\_River\_Baybay\_City\_Leyte\_Philippines

Rahman, A., Jahanara, I., & Jolly, Y. N. (2021). Assessment of physicochemical properties of water and their seasonal variation in an urban river in Bangladesh. *Water Science and Engineering*, *14*(2), 139–148. https://doi.org/10.1016/j.wse.2021.06.006

Igloria, J., Seriño, E. K., Magbanua, F., Mazo, A., & Pogado, F. (2024). Macroinvertebrate community as bioindicator of water quality of Tambis River, Palompon, Leyte, Philippines. *Journal of Environmental Science and Management*, *27*(1), 26–37. https://doi.org/10.47125/jesam/2024\_1/03

Muchanga, M., & Sichingabula, H. M. (2021). Spatial and seasonal dynamics of total suspended sediment, total dissolved solids and turbidity of a lacustrine reservoir in the Magoye catchment, southern Zambia. *European Journal of Environment and Earth Sciences*, *2*(6), 43–48. https://doi.org/10.24018/ejgeo.2021.2.6.227

Mathur, A., Singh, V. K., Shivam, Chaudhary, V., Ali, K., Akram, M., Tiwari, S. N., Roshan, V. K., Verma, S., & Dixit, S. (2024). Assessment of water quality parameters using water quality index (WQI) of upper Ganga basin. *International Journal of Research in Agronomy*, *7*(8), 106–113. https://doi.org/10.33545/2618060x.2024.v7.i8b.1202

Paudel, G., Pant, R. R., Joshi, T. R., Saqr, A. M., Đurin, B., Cetl, V., Kamble, P. N., & Bishwakarma, K. (2024). Hydrochemical Dynamics and Water Quality Assessment of the Ramsar-Listed Ghodaghodi Lake Complex: Unveiling the Water-Environment Nexus. *Water*, *16*(23), 3373. https://doi.org/10.3390/w16233373

Lemessa, F., Simane, B., Seyoum, A., & Gebresenbet, G. (2023). Assessment of the Impact of Industrial Wastewater on the Water Quality of Rivers around the Bole Lemi Industrial Park (BLIP), Ethiopia. *Sustainability*, *15*(5), 4290. https://doi.org/10.3390/su15054290

Pushpalatha, N., Sreeja, V., Karthik, R., & Saravanan, G. (2022). Total dissolved solids and their removal techniques. *International Journal of Environmental Sustainability and Protection*, *2*(2), 13–20. https://doi.org/10.35745/ijesp2022v02.02.0002

Labajo-Villantes, Y., & Nuñeza, O. M. (2014). Water quality assessment of Labo and Clarin Rivers in Misamis Occidental, Philippines. *International Journal of Biodiversity and Conservation*, *6*(10), 735–742. https://doi.org/10.5897/ijbc2012.018

Pleto, J. V. R., Migo, V. P., & Arboleda, M. D. M. (2020). Preliminary water and sediment quality assessment of the Meycauayan River segment of the Marilao-Meycauayan-Obando River System in Bulacan, the Philippines. *Journal of Health and Pollution*, *10*(26). https://doi.org/10.5696/2156-9614-10.26.200609

Malaki, A., Allaoui, M. E., Bakraoui, H. E., Allalat, F., Mabrouki, J., & Slaoui, M. (2024). Spatial evolution of physicochemical and bacteriological water quality at the Mouth of Oued Sebou, Kenitra Province, Morocco. *International Journal of Chemical and Biochemical Sciences*, *25*(19). https://doi.org/10.62877/47-ijcbs-24-25-19-47

Jayasekara, J. M. a. U., Mowjood, M. I. M., & Dayawansa, N. D. K. (2024). Analysis of spatial and temporal variation of water quality: A case study of Kotagala Wetland, Nuwara Eliya, Sri Lanka. *Tropical Agricultural Research*, *35*(4), 343–354. https://doi.org/10.4038/tar.v35i4.8847

Awogbami, S. O., Solomon, O. A., Sawyerr, H. O., & Raimi, M. O. (2023). Comparative assessment of seasonal variations in the quality of surface water and its associated health hazards in gold mining areas of Osun State, South-West Nigeria. *Advances in Environmental and Engineering Research*, *04*(01), 1–61. https://doi.org/10.21926/aeer.2301011

Sanchez, J. M. P., Picardal, M. T., Libres, M. T., Pineda, H. A., Paloma, M. L. B., Librinca, J. M., Caturza, R. R. A., Ramayla, S. P., Armada, R. L., & Picardal, J. P. (2020). Characterization of a river at risk: the case of Sapangdaku River in Toledo City, Cebu, Philippines. *AIMS Environmental Science*, *7*(6), 559–574. https://doi.org/10.3934/environsci.2020035

Alimen, R. A., Tarantan, Z. I., & Nonesco, A. E. (2019). Determining the water quality of Egaña River at the province of Antique, Philippines. *IAMURE International Journal of Ecology and Conservation*, *28*(1), 1. https://ejournals.ph/article.php?id=14757

Effendi, H., Romanto, N., & Wardiatno, Y. (2015). Water quality status of Ciambulawung River, Banten Province, based on Pollution Index and NSF-WQI. *Procedia Environmental Sciences*, *24*, 228–237. https://doi.org/10.1016/j.proenv.2015.03.030

Auta, T., Alexander, A., & Bichi, A. H. (2023). Wet season water quality and zooplanktons community of Jibia Lake, Katsina State, Nigeria. *Asian Journal of Biological Sciences*, *16*(2), 175–186. https://doi.org/10.3923/ajbs.2023.175.186

U.S. Geological Survey. (2019, October 22). *Dissolved oxygen and water.*<https://www.usgs.gov/special-topics/water-science-school/science/dissolved-oxygen-and-water>

Guo, X., Song, G., Li, Y., Zhao, L., & Wang, J. (2022). Switch of bacteria community under oxygen depletion in sediment of Bohai Sea. *Frontiers in Marine Science*, *9*. https://doi.org/10.3389/fmars.2022.833513

Rocha, P. a. C., Santos, V. O., Van Griensven Thé, J., & Gharabaghi, B. (2023). New Graph-Based and Transformer Deep Learning Models for river dissolved oxygen Forecasting. *Environments*, *10*(12), 217. https://doi.org/10.3390/environments10120217

Alimen, R. A., Tarantan, Z. I., & Nonesco, A. E. (2019). Determining the water quality of Egaña River at the province of Antique, Philippines. *IAMURE International Journal of Ecology and Conservation*, *28*(1), 1. https://ejournals.ph/article.php?id=14757

Bertomen, W. K. S., Roa, E. C., Tubio, E. G., Vedra, S. A., & Dela Peña, G. D. (2017). Water quality of Sawaga River, Malaybalay City, Bukidnon, Philippines. *International Journal of Science and Research (IJSR)*, *6*(7), 1090–1095. https://doi.org/10.21275/art20175318

*pH of Water - Environmental Measurement Systems*. (2019, January 23). Environmental Measurement Systems. https://www.fondriest.com/environmental-measurements/parameters/water-quality/ph/

Obasi, P. N., & Akudinobi, B. B. (2020). Potential health risk and levels of heavy metals in water resources of lead–zinc mining communities of Abakaliki, southeast Nigeria. *Applied Water Science*, *10*(7). https://doi.org/10.1007/s13201-020-01233-z

Lawson, T. B. (1995). Water quality and environmental requirements. In *Springer eBooks* (pp. 12–39). <https://doi.org/10.1007/978-1-4613-0479-1_2>

Enguito, M. R. C., Matunog, V. E., Bala, J. J. O., & Villantes, Y. L. (2013). Water quality assessment of Carangan Estero in Ozamiz City, Philippines. *Journal of Multidisciplinary Studies*, *1*(1). https://doi.org/10.7828/jmds.v1i1.397

Borlongan, I. G., Golez, N., V., & Lorque, F. (2010, January 1). *Physico-chemical assessment of the Jalaur River system, Iloilo, Philippines*. BAHÁNDÌAN, Institutional Repository of Central Philippine University. https://repository.cpu.edu.ph/handle/20.500.12852/1672

Boyd, C. E. (2015). Water quality. In *Springer eBooks*. https://doi.org/10.1007/978-3-319-17446-4

Ezenwa, I. M., Omoigberale, M., Abulu, R., Biose, E., Okpara, B., & Uyi, O. (2023). Burial leakage: A human accustomed groundwater contaminant sources and health hazards study near cemeteries in Benin City, Nigeria. *PLoS ONE*, *18*(12), e0292008. https://doi.org/10.1371/journal.pone.0292008

Amadi, S. N., Clement, E., Pelebo, E. T., & Apugo, U. I. (2023). PRACTICES OF OCCUPATIONAL HEALTH AND SAFETY AND EXPERIENCE OF OCCUPATIONAL HAZARDS AMONG SOLID WASTE MANAGERS IN PORT HARCOURT METROPOLIS OF RIVERS STATE. *medRxiv (Cold Spring Harbor Laboratory)*. https://doi.org/10.1101/2023.02.17.23285698